

Coatings
Corrosion

Fracture and Mechanical Testing

High Temperature Mechanical Properties

Hydrogen Production and Storage Materials

Hydrogen Separation Materials

Irradiation

Materials Validation

Microstructure and Physical Properties

Modeling

Neutron Radiography

Nondestructive Evaluation

Post-irradiation Examination

Synthesis and Processing of Novel Materials

Welding and Joining

X-Ray Radiography

Fracture and Mechanical Testing

Capabilities/Facilities

crew-driven and servo-hydraulic mechanical test systems for tensile, fracture toughness, and fatigue testing. Temperature control capability from 150°C to +1100°C. Low and high force capability—50 N to 1000 kN.

Direct current potential drop for crack length measurement, high-temperature fracture mechanics.

Two optical tables for moiré interferometry, laser-based microtopography system for fracture surface characterization.

Small volume irradiated sample testing using shear punch technique.

Materials

High-strength structural steels, wrought stainless steels, metal matrix composites, ceramics, and biomaterials.

Scientific/Engineering Issues

Subcritical crack growth in liquid metal embrittlement conditions, fracture processes in ductile growth of surface cracks, and mechanical property characterization of agricultural biomaterials. Embrittlement of reactor material.

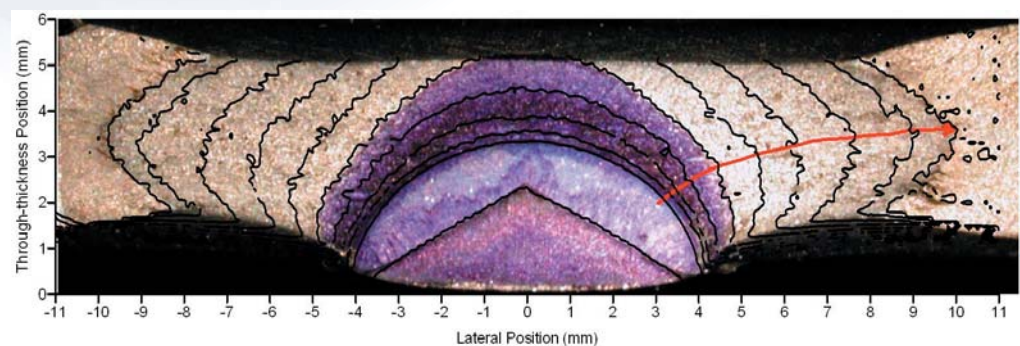
Staff

T.C. Totemeier, E.D. Steffler, J.I. Cole and W.R. Lloyd.

Recent Projects

- Increasing Safety and Reducing Environmental Damage Risk from Aging High-Level Radioactive Waste Storage Tanks, DOE Environmental Management Science Program, \$270K/year
- Fracture of Surface Cracks in Brittle and Ductile Materials under Combined Loading, National Aeronautics and Space Administration, \$75K/year
- Assessment of Part-Through Defect Behavior in the Standardized DOE Spent Nuclear Fuel Canister Subjected to Accidental Drop Conditions, DOE National Spent Nuclear Fuel Program, \$60K/year
- National security related fracture testing, \$100K/year
- Mechanical behavior of irradiated structural stainless steels, nuclear energy plant optimization
- Radiation effects on EBR-II irradiated stainless steel, Argonne National Laboratory/Japan Nuclear Cycle Development Institute collaboration
- JNC collaboration on fatigue crack growth in metallurgically-bonded EBR-II superheater tubes

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Topographic image of a laboratory fracture specimen. Purple dye region shows the crack front position at point of through-thickness penetration. Contrast change on fracture surface marks end of ductile tearing during test.

Science

INL
Idaho National
Laboratory

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INL is a U.S. Department of Energy
national laboratory operated by
Battelle Energy Alliance



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Collaborations

- Massachusetts Institute of Technology, Professor F.A. McClintock
- University of California at Davis, Professor M. Rashid
- Mississippi State University, Professor J.C. Newman

Publications

“Microtopographic Analysis of Part-Through Crack Growth in Alloy 304L Plate-Type Tension Specimens,” W.R. Lloyd, E.D. Steffler and J.H. Jackson, INEEL/EXT-03-00495, 2003.

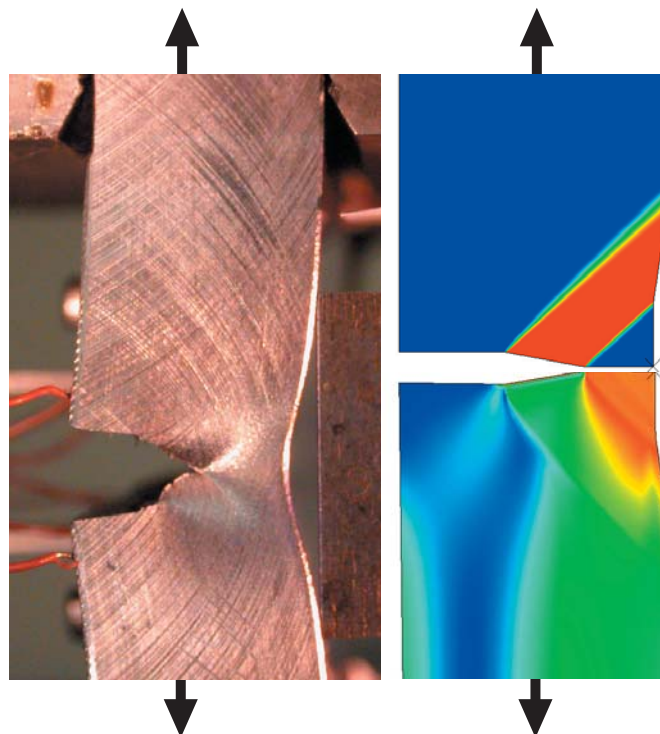
“Microtopography for Ductile Fracture Process Characterization - Part 1: Theory and Methodology,” W.R. Lloyd, *Engineering Fracture Mechanics*, Vol. 70, pp. 387-401, 2003.

“Microtopography for Ductile Fracture Process Characterization - Part 2: Application for CTOA Analysis,” W.R. Lloyd and F.A. McClintock, *Engineering Fracture Mechanics*, Vol. 70, pp. 403-415, 2003.

“Numerical Analysis of Surface Cracks at Regions of Curvature in Oxide Scales,” R.L. Williamson, J.K. Wright, E.D. Steffler and R.M. Cannon, *Materials Science and Engineering*, Vol. A342, p. 109, 2002.

“Properties of 20% Cold-Worked 316 Stainless Steel Irradiated at Low Dose Rate,” T.R. Allen, H. Tsai, J.I. Cole, J. Ohta, K. Dohi, H. Kusanagi, *Effects of Radiation on Materials, ASTM STP 1447*, ASTM International, West Conshohocken, PA, 2003.

“Effects of Irradiation on the Swelling and Mechanical Properties of 316 Stainless Steel,” T.R. Allen, H. Tsai, R.S. Daum, D.L. Porter, J.I. Cole, T. Yoshitake, N. Akasaka, T. Donomae, S. Mizuta, J. Ohta, K. Dohi and H. Kusanagi, *11th International Conference on Environmental Degradation in Nuclear Power Systems-Water Reactors*, 2003.



Experimental observation and finite element analysis of ductile crack growth in a pure extension fracture specimen. In the simulation, equivalent plastic strain is shown on the top and von Mises stress on the bottom.

Experiment

Finite Element Analysis